THE PORTEUS MAZE TEST MANUAL

GEORGE G. HARRAP & CO. LTD.

THE PORTEUS
MAZE TEST MANUAL

BUREAU OF EDU[illegible]TION L AND PSYCHOLOGICAL RESEARCH
GOVT. OF W. BENGAL
LIBRARY
CALCUTTA-19

Also by S. D. PORTEUS

PORTEUS MAZE TESTS

Fifty Years' Application

Owing to their wide standardization, and to their proven reliability, the Porteus Maze Tests have become the most durable instrument in clinical practice today. This book is a discussion of the problems, ranging from the mental status of primitive peoples to the measurement of subconscious memory, which the Maze has helped to solve.

THE PORTEUS MAZE TEST MANUAL

BY

S. D. PORTEUS D.Sc.
REFEREE JUVENILE COURT HONOLULU
PROFESSOR CLINICAL PSYCHOLOGY
UNIVERSITY OF HAWAII

S.C.E.R.T., West Bengal
Library
Calcutta
25/3, B. C. Road

Bureau of Educational & Psychological Research
Library
Calcutta-19

GEORGE G. HARRAP & CO. LTD
LONDON TORONTO WELLINGTON SYDNEY

Reprinted in part from
"The Porteus Maze Test and Intelligence"
(Pacific Books, Palo Alto, California, U.S.A.)

S.C.E R.T., West Bengal
Date 21...3...75 .....
Acc. No. 2478..........

151.2
POR

First published in Great Britain 1952
by GEORGE G. HARRAP & CO. LTD
182 High Holborn, London, W.C.1
Reprinted 1967
Copyright. All rights reserved

21. 3. 75
2478

COMPOSED IN TIMES ROMAN TYPE AND PRINTED BY THE PITMAN PRESS, BATH
MADE IN GREAT BRITAIN

Preface

FROM many aspects 1914 seems a very long time ago. Besides plunging our world into a maelstrom of conflict, that year ushered in a period of vastly augmented activity in science that has proceeded at an increasing pace right up to the present day. In what is optimistically called progress, clinical psychology has shared. In the field of intelligence measurement, for example, there were then but a very few instruments at hand. The spotlight of interest shone on the Goddard Revision of the Binet, the so-called Seguin Formboard, the Healy-Fernald performance tests, and several other series of tests no longer heard of. But there were in casual use many other tests that were the forerunners of tests now popular among psychologists. Long before the Rorschach there was an interpretation of ink-blots, an "imagination test"; a vocabulary test gave measures of basic knowledge of various sciences, etc.; word association, completion, substitution, and analogies tests were represented, though none was applied in diagnosis. Present-day techniques do not, therefore, argue any great access of psychological inventiveness, but rather the exploitation of earlier ideas and devices. The same is true in other fields of practical endeavour. At that time we already had cars, telephones, gramophones, planes, and radio transmission, though our present-day gadgets are undoubtedly much superior.

This much by way of introduction may be necessary to explain why a test devised in 1914 should be written about at length in 1952. There would indeed be no justification except that there is something new to report. As a matter of fact, there has been more significant research on the Maze Test in the past ten years than in any decade previously.

Strangely enough, this has come about not through any new psychological insight, but by recent developments in psychosurgery. Thirty-six years ago, had it been possible to perform, between successive testings, an operation on the brain that temporarily affects social efficiency, the way of the psychologist would have been less hard. Validation or otherwise of diagnostic tests would have been easily feasible. Now this opportunity has come about, but the results with many of the tests have been 'otherwise.' Those that relate to the validity of the Maze are herein reported.

I have been extremely fortunate in having been able to await this opportunity, for it is unusual for a worker who was busy in the inception of the testing movement as far back as 1914 to participate in these modern researches. Generalized accounts of the Maze Test were published in 1919, 1924, and 1933. If the present volume were merely a further historical summary it would have been of little except academic interest, and less value. But it so happens that this whole subject of test validity is related to a most serious undertaking, for these tests are used for the selection of large numbers of human beings for an institutional segregation which may be life-long. Every last atom of proof of validity of these tests should be carefully weighed. This is no academic question, but a vital practical consideration.

In the recent National Institute of Mental Health Conference on Psycho-surgery which the writer attended in New York it was affirmed repeatedly that the Porteus Maze Test was the only test in standard use that consistently reflected personality changes that follow brain damage in the frontal lobes. Neither the Binet, the Wechsler-Bellevue, nor projective tests such as the Rorschach are similarly sensitive. This finding, confirmed by researches in the United States, England, Canada, and Hawaii, seems to make a restatement of the psychological approach to the study of personality advisable.

Individual personality may be considered analogous to a large building to which the psychologist has no key. But, given the problem of finding out what goes on inside, he is allowed the privilege of looking in whatever windows are available. It would, of course, be very unlikely that any single window will give him the information he seeks. The so-called general intelligence tests provide him with one row of peep-holes, possibly along the front of the building. The projective tests allow for some quick glances —but no more—into another side of personality. On the other side, the Porteus Maze Test seems so far to provide the only unshaded window. Perhaps the back of the structure is as yet unbroken. When psychologists discover more windows and have learned to relate all they see the riddle of individual personality may be solved.

In the meantime I am indeed grateful for the fact that recent brain research has enlarged the Maze Test aperture somewhat, has cleaned up some of the murkiness of twenty-five years' accumulation, and thus has given us clearer vision and better understanding of what we see.

S. D. P.

Contents

CHAPTER PAGE

I. Planning Capacity and Intelligence 9

History and Validity. Early History—First Public Presentation—Early Studies in Validation—Relation to Industrial Trainability—Test Inter-correlations—Relation to Social Adjustment—Relation to Delinquency—Practice Effects.

Recent Advances. Psycho-surgery—Mental Effects—Validation of Tests—Tests of General Intelligence—New Proofs of Maze Validity—Relation to Social Improvement—Columbia-Greystone Project I—Columbia-Greystone Project II—Columbia-Greystone Project III—Freeman-Watts Researches—Relation of Planning to Intelligence.

II. Guide to the Use of the Porteus Maze Test 26

Test Instructions. General Note—Summary of Testing Rules.

Test Procedure. Year III—Year IV—Year V—Year VI—Year VII—Years VIII, IX, and X—Year XI—Years XII and XIV.

Scoring. Examples.

Qualitative Scoring. Error-points.

Alternative Procedure for Adults. Administration—Interpretation of the Quantitative Maze Score—The Qualitative Scoring of the Maze Test.

Appendix I. Examples for Scoring Wavy Lines 43

Appendix II. Scoring Sheet 51

Appendix III. The Age-score Ratio 52

List of References 63

CHAPTER I

Planning Capacity and Intelligence

HISTORY AND VALIDITY

EARLY HISTORY

The Porteus Maze Test, like the Binet, was originally devised for the purpose of meeting the problem of the more accurate diagnosis of feeble-mindedness. In 1912 the writer had been given the responsibility for selecting mental defectives for attendance at a special school set up in the city of Melbourne. By 1913 several hundred children had been examined in the ordinary school classes and segregated on the basis of their performance on the Goddard Revision of the Binet-Simon scale. As special educational efforts proceeded on their behalf, it was discovered that their classification by Binet mental age did not reflect adequately their practical intelligence. In manual training of various kinds some children with comparatively good scores made very little progress; others, much duller, made good industrial progress, and were so temperamentally stable that they were declared not feeble-minded.

It seemed to the writer at the time that the deficiency of the Binet scale was one of scope. Lack of ordinary prudence and planning capacity distinguished the feeble-minded just as much as did poor memory, insufficient common knowledge, or restricted vocabulary. In addition, the scale was a verbal one requiring verbal response, and verbal facility and practical performance were not closely related. The writer therefore began experimenting with other test approaches. Maze-threading seemed to examine, best of all, certain socially essential traits or abilities not covered by the Binet scale.

FIRST PUBLIC PRESENTATION

In August 1914 the Maze series was first described at the Melbourne meeting of the British Association for the Advancement of Science. It met with an excellent reception, and in June 1915 two articles illustrating the test and its uses were published in England[1] and America.[2]

The test designs as first published went only as high as twelve and thirteen years, in which three trials were allowed. The method of validation was that of comparison with Binet scores. Seventy-five per cent. of a group of 120 defectives scored within one year of their Binet age, and this was taken to mean that the new scale deserved recognition as a supplement to the Binet.

In 1918 another study[3] reported correlations between Maze and Goddard-Binet of ·7 for 200 mental defectives, ·69 for 190 normal children. For 263 normal children examined by the Stanford-Binet revision the coefficient was ·77. This was the highest coefficient reported, but chronological age was not taken into account.

In 1919 the writer went from the University of Melbourne to direct the Psychological Laboratory at Vineland, New Jersey, succeeding Dr H. H. Goddard. Two monographs[4, 5] giving, among other things, the results of the application of the Maze to two groups of normal children, numbering 1000 and 1285, respectively, who ranged in age from five to fourteen years, were there published. Some changes aimed at making the tests more difficult at the lower and easier at the upper levels were embodied in the first monograph. This early edition of the tests was not copyrighted, and distribution was through the Vineland Training School and Messrs Stoelting and Co., of Chicago.

This standardization was tested by Professor Cyril Burt in London in 1921.[6] The table of norms compiled by him showed that, with the exception of years five, six, and fourteen, the tests were well standardized. In 1924 a guide-book[7] was issued by the writer containing two adult mazes and a modified scoring system. The form of the test now in use was published in 1933,[8] and various investigations showed that when the Maze designs were treated as an age-scale the series was properly standardized.

EARLY STUDIES IN VALIDATION

The early validation of the Maze followed the usual procedures current in those days. A number of studies by the writer and others reported correlations with the Binet and other tests. The average Binet-Porteus coefficient for a large number of investigations was about ·65, high enough to show a fairly close relation with general intelligence (so-called), low enough to indicate that the Maze was measuring certain mental capacities not covered by a Binet examination. The most important question was with regard to the value of those capacities for social adjustment. If this question could be answered affirmatively the bearing that Maze performance would have on mental diagnosis could be determined.

In 1920 a monograph[9] was published from Vineland which reported just such an investigation. A social rating scale had been devised, based on social traits that had been determined experimentally as having the closest relation to estimates of the degree of social inefficiency of the feeble-minded. The subjects were mental defectives resident at Vineland Training School for five years and upward, the raters being the educational director, the supervisor of the boys' cottages, and the director of the hospital at the institution. Seven traits, including lack of planning capacity, suggestibility, impulsiveness, were shown statistically to form the non-intellectual basis of mental defect. The research was then transferred to the Rome (New York) State School for Defectives, and the scale tested against the observed success of high-grade feeble-minded cases on parole, and in industrial and farm work. The scale proved to be a very adequate measure of social and industrial competency at the moron level.

Used in conjunction with the Binet, the Maze, and other mental tests, the social rating scale provided a useful criterion of validity. The Porteus Maze was found to have a somewhat closer relation to social adaptability than the Binet, and a consistently higher correlation with the social criterion than any other performance test. All these findings were presented in book form and discussed in 1922.[10]

RELATION TO INDUSTRIAL TRAINABILITY

The writer's own studies, which indicated that the Maze was a good measure of practical ability as contrasted with verbal ability, received ample confirmation from various sources. In 1930 Dr Henry Herd reported a study made in the Manchester Special Schools.[11] A close correspondence between ratings on manual ability and Maze scores was shown. In addition to the above conclusion, Dr Herd stated that "no child with a Porteus Ratio (test or intelligence quotient) below 50 made anything but a very poor appearance in manual work."

In the course of an extensive study carried out by Earle and Milner in London[12] the value of the Maze in predicting achievement was also demonstrated as being above that of any other performance test used. One of the earliest investigations along these lines was that instituted by Ross in Scotland.[13] The correlations between success in handwork and tests were: Tapping, ·60; Form Boards, ·64; Stanford-Binet, ·69; Maze, ·76.

TEST INTER-CORRELATIONS

Many investigators have reported the correlations existing between the Maze and batteries of various tests. One of the most careful of these reports was that of Morgenthau.[14] This showed that the relationship of the Maze with a whole array of diverse tests, which included the Binet, the Healy Completion, the Pintner Non-language, the Healy Bronner Learning Test, the Thorndike Reading, and the Tapping Test, were surprisingly high. This catholicity of relationship of the Maze has been commented upon many times, tests of the most various natures showing significant correlations. These findings, confirmed by the writer's own, seem to be of considerable importance, and support his view that all intelligence tests are, to a greater or less degree, tests of planning capacity. Studies such as those by Worthington[15] and Gaw[16] provide additional inter-correlational data. Even with primitive groups who have had no industrial training the Maze correlates highly with a battery of performance tests. This was reported by Vicary working with aboriginal Indian subjects in Bengal.[17]

RELATION TO SOCIAL ADJUSTMENT

A somewhat indirect approach to the problem of validation of the test has been provided by various group comparisons. The scores of individual groups of varying social inefficiency have been cited. Noteworthy among these were two studies carried out among delinquents in New York City. The first, by Poull and Montgomery in 1929,[18] divided children committed to the

City Children's Hospital at Randall's Island into socially maladjusted and socially well-adjusted groups. The investigators found no significant differences between the Binet scores of the two groups. In Maze performance, however, though the maladjusted were on the average five months older, they scored a year less than the well-adjusted, equivalent to 8·6 test quotient points, a difference that was statistically reliable.

Complete confirmation of these results was afforded by Karpeles,[19] working three years later in the same institution. In this study the differentiation by the Maze of the two groups was even more striking, especially for the more intelligent children. However, these group comparisons are not entirely satisfactory as proofs of validity. All that they proved was that the Maze score was more closely related, in general, to social adjustment. They did not indicate what behaviour traits were reflected in test performance, nor to what extent Maze reactions could serve as a basis for prediction of future adjustability.

RELATION TO DELINQUENCY

As far back as 1917 the writer had had published various studies[20] which dealt with the performance of delinquents in the Maze. Briefly summarized, these showed a distinct tendency for delinquents to fall below normal performance, though the deficiency is not nearly as marked as in the case of defectives. Some delinquents, however, tended to score well though they were obviously socially maladjusted in conduct.

In a discussion of this situation in 1922* it was pointed out that failure in the Maze is more significant than success. The opposite is true of the Binet; there success is more significant than failure.

The reasons why the Maze does not always differentiate delinquents and psychopathic individuals from normals were suggested at that time, particularly the fact that the Maze presents "a short, well-supervised test of a novel nature," and that the puzzle-solving interest appeals to children who like to "show off." It was pointed out that the Maze tended to overestimate the social abilities of children who were egocentric and obtrusive—the type of many delinquents—and who perform at their best so long as they command the full attention of the examining psychologist. Social foresight and foresight as measured by the tests did not always correspond.

---

* S. D. Porteus, *Studies in Mental Deviations* (Smith Printing House, Vineland, 1922).

Though this defect in the Maze was long recognized, the writer did nothing to correct it until 1942, twenty years later.* An analysis was then undertaken of the qualitative responses of delinquents and non-delinquents in the test, and a new scoring independent of mental age was devised. A monograph[21] was published on this matter, giving details of this scoring, and this was followed up by a supplementary study in 1944,[22] which included, besides delinquent and criminal group records, comparative scores of children rated "undependable" by teachers, as well as scores of cannery-workers and bus-drivers.

Two researches in widely different parts of America confirmed these results. Wright applied the qualitative scoring to the Maze performance of delinquent boys at the Whittier State School in California, and found their average qualitative error score to be 49 points, exactly the same as the error score of delinquents in Hawaii.[23]

Grajales made a similar study of the scores of a group of delinquent boys at Bellevue Hospital, New York, and found an even more pronounced difference between their qualitative error performance and the non-delinquent average.[24] This group contained many recidivists, and their average qualitative error score was 60.

In the writer's present work as Referee of the Juvenile Court at Honolulu, hearing delinquent and dependent cases, he finds the qualitative score of the utmost value in predicting success on probation. Taken in conjunction with the mental-age performance, this use of the Maze provides a measure of dependability which is the most reliable basis of social prognosis yet available. This is not surprising, considering the fact that the qualitative scoring is based specifically on delinquent reactions.

PRACTICE EFFECTS

One drawback to the Maze which was noted as early as 1918 is the fact that in a second application of the test practice effects are usually evident. It was pointed out that in proceeding through the series of designs the same situation occurred over and over again, giving the subject an opportunity to change his approach to a more prudent form of behaviour. Thus he became 'test-wise,' and this attitude helped him greatly on his second experience with the test. Individuals, of course, differ in their capacity to profit by this experience. In 1922, a modification of procedure and scoring was proposed[7] so as to yield a more equivalent score on the second application. The test designs were presented in an inverted position; only one trial was allowed in each test up to the eleven-year design, and three trials in the twelve- and fourteen-year tests. One year was deducted for each failure, and a special scoring adopted for the sum of the trials in the two highest tests. Some psychologists have not paid due recognition to the practice effects on repeated application, and thus have been led astray, particularly in assessing the mental effects of brain damage. There would be advantages in supplementing the present Maze series by a more difficult form which would yield an equivalent score on a second application. It is hoped that this supplementary series will soon be available.

---

* A listing of these responses, preliminary to covering them by a scoring system, was contained in *The Practice of Clinical Psychology* (American Book Co., 1942).

RECENT ADVANCES

Students of brain evolution have long recognized that the frontal lobes of the brain represent its most distinctively human development. In a book[25] aimed at presenting a synthesis of neurological and psychological viewpoints Wood Jones and the present writer have this to say with regard to frontal-lobe evolution:

> In the Tree Shrews and in the Tarsiers there is very little cortex in front of the motor area of the brain. But as the arboreal primate phylum is ascended this pre-motor or frontal area of the cortex steadily enlarges, and it may be said with justice that the great outstanding feature of the human brain is the immense size of the cortical area lying anterior to the motor centres; . . . it seems not unlikely that it may be an association field of the centre for deliberative movement.
>
> As such it would appear likely that it was concerned with that extension of the production of deliberative movement that we have termed humanly adjusted social conduct.

We then proceeded (Chapter XLIII) to summarize briefly the effects of frontal-area injuries as observed in the First World War. "In lesions of the frontal area this is the type of conduct that is produced. The patient is incapable of considering, of weighing, of deliberating his actions—he acts on impulse. . . ."

PSYCHO-SURGERY

The above was written in 1929. From 1936 onward new light has been thrown on frontal-lobe functions by a variety of brain operations which are now included under the term psycho-surgery. These began with experimental procedures by Burckhardt in Switzerland in 1890 for the relief of psychotic conditions, and later these were continued by Egas Moniz in Portugal in 1935. A little later Freeman and Watts[26] introduced the operation of lobotomy, as they called it, to America, and subsequently modified the Moniz surgical procedure. Their operation severed most of the subcortical connexions between the thalamus and the prefrontal areas on each side of the brain. Known as leucotomy in England, this surgical procedure has now been widely applied, with probably 12,000 operations already performed in the U.S.A. It has, therefore, passed the experimental stage, and is now recognized as a standard procedure, to be used conservatively, only after all other approaches, such as electric shock, insulin, and other therapies, have failed. Of such patients roughly one-third recover from their psychosis so as to merit discharge from mental institutions, one-third are obviously improved, and one-third remain unimproved.

MENTAL EFFECTS

The effects of this fairly well-standardized or controlled brain damage by operation support in a considerable measure the theories of frontal-lobe functioning previously set forth. These brain areas are not the seat of intelligence considered in its broadest sense, but seem to underlie what Wood Jones and the present writer termed "humanly adjusted social conduct."

Immediately following recovery from the operation itself the great majority of patients remain for a time in a state wherein social and industrial planning is at a minimum. Freeman and Watts,[27] after observing many hundreds of patients, have reached the following broad conclusion: "Truly, if there is any way of summing up in one word the function of the frontal-association areas, that one word should be foresight."* This lack of planning ability characteristic of lobotomy patients is shown both socially and industrially; in other words, it is apparent in the patient's responses both to people and to work.

Thus the first few weeks immediately subsequent to lobotomy or leucotomy are marked by what these authors call "surgically induced childhood," in which lack of foresight, mental inertia, or lack of initiative are the outstanding deficiencies. Surprisingly enough, other capacities, usually termed intellectual, are on the whole very little affected. The patient reads, remembers, retains the same range of vocabulary and common knowledge and arithmetical ability as before the operation. Furthermore, after approximately a year, discharged patients appear to have recovered to such a degree that it is evident either that new pathways to the frontal lobes have been activated or else that other brain areas are contributing a degree of foresight to the patient's behaviour. The writer is careful to say "appear to have recovered"; he is one who believes that restoration is far from complete, but that psychological tests are somewhat inadequate for the full demonstration of the post-operational deficits.

VALIDATION OF TESTS

Thus through psycho-surgery entirely new and quite spectacular methods of testing the validity of tests used for social intelligence and its evaluation have been provided. No psychologist had ever envisaged, except in his dreams, such a crucial experiment as: (1) the application of intelligence tests to selected patients; (2) cutting the subcortical communication pathways of the frontal lobes, as in lobotomy, or excising selected cortical areas, as in topectomy, or other frontal operations, all of which tend to reduce cases to almost complete social dependency; (3) applying the tests post-operatively to show which tests are sensitive to the impairment of social intelligence. Yet psycho-surgery does afford just such an opportunity to examine the validity of tests used in diagnosis and social prediction. More particularly, since clinical observation seems to indicate that the social dependency is related definitely to lack of foresight and initiative, the operative procedures would provide validation or otherwise for the Porteus Maze, which, it is claimed, measures just those capacities.

---

* *Psycho-surgery* (second edition), p. 484.

TESTS OF GENERAL INTELLIGENCE

As far as the results of psycho-surgery go, the weight of evidence indicates strongly that tests such as the Binet or the Wechsler-Bellevue show no consistent pattern of loss after operation. Some studies have demonstrated impairment, others no deficits after operation. This discrepancy in results may be due either to insufficient numbers of cases or to variations in the severity of the psycho-surgery. In lobotomy or leucotomy the plane of the incision, whether anterior or posterior, or in topectomy a superior or orbital site of ablation, has quite a marked effect on both the patient's behaviour and the test results. The more anterior the site of the damage the less the mental effects. The general conclusion seems justified that tests such as the Binet or Wechsler-Bellevue are not sensitive, except in the most radical operations, to the clinical changes that are observable post-operatively. The same is true of most of the performance tests, including even the Kohs Block Design, commonly considered to examine planning to some degree. In this regard we can only quote the considered experience of Freeman and Watts:

> Here sits the operated patient and breezes through our tests better than most of our friends and relatives could, and there he proves to be utterly incapable of keeping house, holding a job, getting along with the family, and using his money wisely.*

These strictures do not, however, apply to the Maze, as the experience of Freeman and Watts clearly shows.

NEW PROOFS OF MAZE VALIDITY

In 1944 the present writer and Kepner presented for the first time the results of pre-operative and post-operative applications of the Maze to seventeen lobotomy patients.[28] We reported that only 6 per cent. of these cases improved their scores on the second (post-operative) application of the tests. In striking contrast to this finding, 71 per cent. of a control group of seventeen non-operated clinic cases improved their standing. The net loss of the lobotomy cases was about two years in mental age, whereas the control group gained about the same amount. The Binet post-operative loss was only about three points of I.Q. level, while the Maze deficit amounted to fourteen points.

---

* *Psycho-surgery* (second edition), p. 312.

This experiment, with larger numbers and more applications of the tests, was repeated in 1947, and the results issued by the present writer and Peters.[29] Fifty-five patients were compared with 55 criminals who had been given at least two Maze tests, and who were of the same social grade and approximately the same mental average as the lobotomy cases. About 66 per cent. of the patients declined in performance on the second or post-operative test, as against only 14 per cent. of the controls who had lower scores. But some of the patients declined on some later examination below their pre-operative level, so that in all 82 per cent. showed impaired performance in the Maze at some one or other of their post-operative trials. For this phenomenon of delayed effects of operation the writer has no adequate explanation. There seems to be an analogy with the persistence of physical functioning of a muscle the nerves to which have been cut. It has been noted that as long as thirty-six hours may elapse before the muscle loses its ability to respond to electric stimulation. Apparently muscle cells as well as brain cells have memory. In the same way behaviour formerly carried on through frontal-lobe functioning seems to persist normally in some cases for a time after lobotomy. We all possess, though in varying degrees, the urge to behave consistently or according to pattern, even after the disruption of previously established circuits of response.

As regards practice effects, these should have been much greater for the control group than for the patients, though the reverse was true. The average elapsed time between application of the first and second tests was, for the controls, 4·7 years, as against only 7·7 weeks for the lobotomy cases; yet improvement attributable to practice was much less for the latter group.

The net loss for the leucotomized patients was 1·65 years in Maze score; the net gain for the criminals was 1·6 years, a total difference of 3·25 years. All differences were statistically reliable.

Relation to Social Improvement

The present writer and Peters examined the relation between post-operative scores and improved social adjustment by dividing their cases into three groups according to their classification by psychiatrists as to degree of recovery. Group I consisted of those who improved to such a degree that they could be discharged from the hospital, many to return to industry. This group suffered just as pronounced a deficit post-operatively as others who did not show this amount of ultimate improvement, their loss being equal in amount to the control group's gain. But by the third post-operative testing this greatly improved group were a little ahead of their pre-operative level. This regain does not, however, represent full recovery of Maze test functions—far from it. Intending to show how normal children improve with practice, the writer recently gave successive tests to a bright boy aged eight years three months. The first test gave him a score of twelve years, the second fourteen years, and on the third testing he reached the ceiling of the test, or seventeen years, and since there could be no further improvement continued testing was useless. Lobotomy patients' ability to improve with practice, though apparent, is much less than normal. Though their first average score was little less than this eight-year-old child's, none of them had reached as high a score in six applications as the boy had in three.

Group II of the patients represented those who showed marked improvement, but not to the degree that warranted discharge, and these patients required four post-operative testings to reach their pre-operative level. Group III, who were classified by the psychiatrists as unimproved, did not in five post-operative testings quite succeed in reaching their pre-operative position, in spite of this extraordinary amount of practice in the test. Generally speaking, the patients who showed a marked initial loss followed by a relatively rapid regain of Maze-tested functions had the most favourable social prognosis.

Columbia-Greystone Project I

In 1948–49 a research team consisting of neuro-surgeons, psychiatrists, psychologists, and various medical specialists collaborated in a thorough study of the mental effects of topectomy, or ablation of selected portions of the prefrontal cortex, the areas corresponding to numbered sections of Brodmann's map. The results appeared in a large volume published under Mettler's editorship at the end of 1949.[30] The psychological group of researchers was under the direction of Professor Carney Landis, and out of a hundred available tests they chose thirty-five for application, both pre-operatively and post-operatively, to the patients. Only the briefest summary of the results can be presented here.

In all the number of test applications was 135, and Dr Landis remarks that nine times out of ten there was no change either in the averages or the variability of the operated group. This lack of sensitivity to frontal-lobe damage applied to the Wechsler-Bellevue, the Word Association, most memory tests, and the Rorschach Tests. As regards tests of psychological function, the number of patients was nineteen, and of carefully matched controls thirteen. The reasons for including the Porteus Maze are stated by Dr H. E. King,[31] who reported these results, as being due to the fact that the present writer has always contended that intelligence is not well measured by tests of the Binet type, especially as regards such socially essential traits as foresight and planning:

Date 21.3.73
Acc. No. 2478

> Since specific claims have been made that this test measures planning initiative and common-sense judgment in practical situations it would be expected to reflect alterations of these traits in intelligence in post-lobotomy cases if, indeed, these traits are as modified as the accounts of clinical observations would lead us to believe. . . . We have included the Porteus Maze Test in our battery because of its fundamental difference in the approach to the assessment of human intelligence.

Results of Project I. The validity of the Maze was therefore seriously in question; the results were just as clearly confirmatory. The operated group lost 1·2 years in test age on the first re-testing, whereas the control group gained one year. On the third application (second post-operative) there was still a difference of 1·7 years separating operatees and controls, and the former had not quite caught up by the fourth testing. Moreover, the pattern of distinct initial impairment followed by early recovery of

R.T., West
151·2

Maze-tested functions was found to be characteristic of those patients who made a good social recovery. Many times in the study the conclusion that this pattern is "strongly associated with social improvement" is reiterated. Out of six patients rated by psychiatrists as showing the greatest social improvement five exhibited the characteristic pattern. In comparing these results with those following lobotomy it should be remembered that some areas selected for ablation were more anterior, and that area 11, for example, caused no impairment, whereas ablation of area 8 caused the greatest loss. Areas 9, 10, and 46 were somewhat less affected, yet all patients' performances were combined in calculating the average score.

Since the Wechsler-Bellevue test is widely used as a measure of social inefficiency, it is noteworthy that no significant differences could be found between pre-operative and post-operative scores in this test, except for two sub-tests (Object Assembly and Digit-symbol), nor was there any relation between scores, brain areas removed, and social improvement of patients.

COLUMBIA-GREYSTONE PROJECT II

The first project was followed up by a second, the results of which are still in course of publication. It was concerned with a variety of surgical procedures, including cortical venous ligation of two degrees of severity, transorbital lobotomy, thermocoagulation, and thalamotomy. The results on the whole agreed well with those observed for topectomy and lobotomy, and are reported by Sheer and Shuttleworth[32] and quoted by Landis.[33] Again, the Wechsler-Bellevue Scale showed no significant differences between performances before and after operation, except that in two of the tests of the performance scale the patients were not able to gain by practice as much as did the control group, and this was particularly true of the venous ligation sub-group when the ligation extended further in a posterior direction. But the results with regard to Porteus Maze performance were more definite, and for some sub-groups striking. The immediate post-operative losses ranged from 0·8 years in the transorbital subgroup to 4·2 years in the thalamotomy cases, with the severe venous ligation cases suffering a deficit of 3·9 years. The total average Maze loss was 1·5 years. The investigators report some recovery three months later, but with less practice gains than with the control group.

COLUMBIA-GREYSTONE PROJECT III

In this study[31] Daniel Sheer reports on the effects of superior as against orbital (more anterior) cortical ablations. He states that his data clearly indicate a considerable loss in Maze performance immediately following operation, and that changes are also reflected qualitatively. But the impairment is not nearly as marked for the orbital group as for the superior group. The loss in the first instance was 0·8 of a year in mental age, for the latter group 2·53 years. Thus the conclusion previously indicated—namely, that the more radical or posterior the operation the greater the loss both as regards mental and social effects and Maze test performance—is justified. In short, the sensitivity of the Maze was again demonstrated.

Summing up the results of all four studies in combination, Sheer finds that there are six tests that consistently reflect the changes that follow psycho-surgery: the Arithmetic, Similarities, Object Assembly, and Digit-symbol sub-tests of the Wechsler-Bellevue; the Capps Homograph Test; and, finally, the Porteus Maze Test. It would seem, therefore, that some combination of these six tests would provide the surest basis of mental diagnosis. However useful in other directions or for other purposes Picture Arrangement, Picture Completion, Block Design, Information, Comprehension, Digit Span, and Vocabulary may prove to be, they are not of much significance in the diagnosis of feeble-mindedness. As regards the mental traits covered by such tests, this is in substance the conclusion issued by the writer in 1915, and confirmed by various studies following that date.

FREEMAN-WATTS RESEARCHES

One final citation should be made, and that is from the pioneers of psycho-surgery, Freeman and Watts, who have continued their work up to the present time. Their latest conclusions are contained in the second edition of their epoch-making work. To this Mary F. Robinson[35] contributes a section on the effects of lobotomy on the personality of patients. For her inquiry she used the records of 68 patients "probably representative of the

500 or more who have made fair to good recoveries under the Freeman and Watts techniques."

Thus Robinson's cases most resemble the patients of Group I in the Porteus-Peters investigation. Her control group, consisting of twelve formerly psychotic patients who had recovered without operation, scored 13·9 years in the Maze, as compared with 10·6 years for the prefrontal operation cases, a deficiency of 3·3 years. This finding is of the utmost importance, as it shows that when patients have not received the benefit of practice in the Maze through a former application the *permanent* defects as regards planfulness are fully demonstrated. The differences as found by Robinson are statistically significant. The Binet Vocabulary score showed no such deficiency in the lobotomy group. The results with the Maze should go a long way towards refuting the view that the deficits in performance are only temporary.

Robinson's data confirm the previous conclusion that the more drastic the operation the more pronounced the Maze impairment. Fifty-four cases who underwent a "standard" lobotomy scored 3·3 years below the controls, while ten "radical operation" cases were deficient 4·3 years. She characterizes the Porteus Maze as a test of planning, ability to alternate attention, and as a gauge of clinical status, and states that her results confirm the present writer's findings and those of other investigators of the Maze. Her summing up of these conclusions is that "there is definite loss after prefrontal lobotomy."

RELATION OF PLANNING TO INTELLIGENCE

In a book published in 1941[36] the writer pointed out how essential planning and prehearsal are to every intelligent act. Until the activity becomes automatic through repetition this prehearsal and choice of alternatives is characteristic of speech, literary composition, painting, solution of mathematical problems, engineering, social adjustments, mechanical operations, and so on through the whole list of humanly adjusted conduct. All mental tests therefore require planning, but the Maze is the most specific test of planfulness, especially at the level of social sufficiency. Two important conclusions follow. The first is that if planning is an integral part of any intelligent act the definition of intelligence is itself defective unless it contains a reference to planning. In 1929 Wood Jones and the present writer[25] had suggested making the capacity to respond to a wide range of relevant stimuli the basis of the definition of intelligence. They further described the relevant stimulus as being one to which it is biologically advantageous for the organism to respond. As regards human behaviour, biological advantages would include social advantages. I would now amend this definition to accord with the new findings so as to read: "Intelligence is the capacity to make planned responses to a wide range of relevant stimuli."

The second conclusion follows the demonstration that the Maze Test is the one standardized test that is consistently sensitive to any mental changes that follow any severe surgical interference with the frontal lobes. These changes which are most marked immediately following operation affect the social sufficiency of operatees to a considerable degree. Since feeble-mindedness is a condition of social insufficiency dependent upon demonstrable mental defects, it follows that the application of the Maze is always indicated whenever mental diagnosis of feeble-mindedness is attempted. This, again, is merely the reiteration of a claim made thirty-seven years ago.*

---

* While this manual was passing through the press several relevant studies have appeared. *Problems of Psycho-surgery* (edited by Mettler and Blakiston) contains a 43-page analysis of Wechsler-Bellevue, Porteus Maze, Weigl, and Homograph test results; Peters has published a study showing that the Maze adequately reflects social improvement following group psychotherapy (*Journal of Consulting Psychology*, October 1951); the proceedings of several psycho-surgery conferences are appearing as U.S. Public Health Publications; while Tizard has recently brought out a survey of the Porteus Maze, which, though inadequate in some respects, gives an excellent summary of work yet to be done on the test.

S.C.E.R.T., West Bengal
Library
Calcutta
25/3, B. C. Road

CHAPTER II

*Guide to the Use of the Porteus Maze Test**

TEST INSTRUCTIONS

1. Do not begin testing above the five-year level, no matter what the age of the subject. The standardization has been arranged, not for the single tests, but for the tests as a series. Hence their difficulty for the upper years would be materially increased except for the practice afforded in working through the series. With an adult, where there is a danger that the subject may underestimate the task, it should be explained that the tests grow increasingly difficult, and that the easiest designs are presented first in order that the subject may understand the nature of the test.

2. Testing is continued until failures have been recorded in any three tests or in two successive tests above eight years. In the case of foreign-born children or others in whom there is a language disability so severe as to preclude them from understanding the verbal directions the five-year test may be used for demonstration purposes. In case of failure in the five-year test the examiner should demonstrate the correct solution before proceeding to the higher tests.

3. Two trials are allowed on each test up to and including the tests for year eleven. Four trials are allowed in the twelve- and fourteen-year tests and in the adult test when applied.

4. An error is recorded and a new trial commenced when the subject's pencil crosses an imaginary line that might be drawn across the opening to a blocked passage. The only exception to this rule is when the error is obviously due to a slip of the pencil, the child not intending to enter the wrong passage. This very rarely happens, and in each case a new test sheet should be substituted and the trial not counted. Markedly poor motor control is the only justification for this leniency.

---

* Reprinted from *The Porteus Maze Test and Intelligence* (Pacific Books, Palo Alto, California, U.S.A.).

5. The subject must never be allowed to correct an error by partially retracing his course. Some examiners are too lenient and allow the subject to proceed after he has gone a very short distance up a blind alley, and then makes a quick self-correction.

(The object of discontinuing the trial and giving the subject a new test design is the dual one of impressing on him the fact that he has made an error, and also of discovering whether he will either repeat the same mistake or make another in an earlier part of the design. Having made one error, the subject will often decide to explore another blind alley before he reaches his former error point.)

In order to allow of the most complete qualitative scoring the procedure is not to stop the subject as soon as he makes an error, but to allow him to go on to the end of the blind alley or until of his own accord he stops drawing, thus showing that he realizes that a mistake has occurred.

6. Never allow more than the prescribed number of trials, except as especially provided in these instructions. To allow additional trials is to give added practice.

7. The child may study the test in advance, but should not be allowed to trace the course with the finger or with the pencil in the air over the design. If the subject attempts to do this, cover the design with the hand and explain that this is not allowed.

8. Lifting the pencil from the paper while drawing through the design after the initial warning not to do so is a qualitative but not a quantitative or mental scoring error. (See the detailed instructions as to how and when this warning is to be given.)

9. Crossing the printed lines in a successful maze-threading is a qualitative error. It is not scored as a quantitative error except when the subject attempts to cut across to reach an opening instead of pursuing the proper course. This most commonly occurs near the beginning of the eleven-year test.

10. If a subject, after failing in the test in the prescribed number of trials, succeeds in the next higher test the latter should be inverted and presented as a new test. Whenever a test is inverted the worse record made by the child in the two applications is recorded; in other words, penalty for error is imposed whether incurred on either, but not on both the original or inverted

application. Thus the child who fails the ten-year test, succeeds in the eleven-year test on the first trial, but takes two trials when the eleven-year test is inverted, has these two trials scored against him.

11. The examiner should sit preferably facing the subject and holding the top of the test sheet firmly on the table with the tips of the fingers. This keeps the test squarely in front of the child, and is the best position for the examiner to watch the child's reactions closely.

The test sheets, gummed together into pads or tablets, should be laid face down beside the examiner, so that a new test sheet can be torn off readily and presented to the child for each new trial.

GENERAL NOTE

As soon as the subject has finished with a test sheet the examiner should record on it the number of the trial, and also the number of times the subject has lifted the pencil if this qualitative error has occurred. These pencil-liftings must be very carefully counted, as it is sometimes hard to see by the record where these have occurred. A number followed by the initials L.P. will serve as a notation, so that the subject will not realize that his errors are being recorded.

SUMMARY OF TESTING RULES

1. Begin testing with all cases above the age of five with the five-year test.

2. Continue testing till the child has failed in any three tests or in two successive tests above eight years.

3. Give two trials in each test up to test eleven, four trials for the twelve, fourteen, and adult tests.

5. The child must not be allowed to correct his error by retracing the course.

6. Not more than the prescribed number of trials in any test should be given, except where expressly provided for in the instructions.

7. Tracing in the air or with the finger is not allowed.

8. Attention is drawn to the detailed testing procedures with regard to the warning against lifting the pencil from the paper in the course of working through a maze design. This is given at

the introduction to the test for Year V, and not again until ten liftings have been counted and recorded. At this point a second warning should be given. (See directions for qualitative scoring, p. 35.)

9. Cutting directly across a line to an opening is an error.

10. Penalize every intentional error. Accidental errors hardly ever occur.

11. If a child succeeds in a test after failure is recorded in the test immediately below, invert the test and score the worse record.

12. The test sheet should be held by the examiner squarely in front of the subject.

TEST PROCEDURE

YEAR III

Examiner says:

"Look at these lines on the paper. I want you to take this pencil and draw round between the lines just as carefully as you can without touching them, like this. Be sure to keep the pencil right between the lines." (Examiner illustrates by drawing about an inch along the path, starting at the point marked "S" and in the direction of the arrow. If necessary, he may hold the child's hand and guide the pencil down to the first angle of the design. If the child does not understand instructions through lack of knowledge of English the test should be demonstrated on another sheet before the child attempts it.)

Scoring. Two trials are allowed, and three-year credit is given if on either trial there are not more than three errors in crossing the lines. Any attempt to trace round the design, however crude, indicates about a two-year level of ability.

YEAR IV

Examiner says:

"Do this just the same way. Start here. Draw right round between the lines, but be sure not to cross any lines." (Examiner indicates the starting-point and the direction in which the pencil is to move. Two trials are allowed, and four-year credit given if on either trial there are not more than two errors made by crossing the lines.)

YEAR V

Examiner says:

"I want you to imagine that all the lines in this drawing are stone walls with spaces between them. A rat came along and found this hole [indicate the beginning of the test] and ran through until he found this piece of cheese. Now, what I want you to do is to take your pencil and draw a line just like this from the rat to the cheese." (Examiner draws slowly with a careful right turn from the nose of the rat round the first corner in the maze.) "But you must be careful not to cross any lines or go up any places that are blocked at the ends. *And one more thing you must remember*: you can stop anywhere as long as you like, but be sure not to lift your pencil from the paper until you have finished and found your way right out."

Two trials are allowed in this test. If a mistake is made the examiner may show the subject that the way is blocked before giving the second trial. This is the only test in which it is allowable to show the child just where the pathway is blocked. In other tests he is told that he cannot get out, but the actual block in the path is not pointed out.

Note. In testing the deaf and dumb, or primitive children, or those who have no understanding of English, the test can be applied by pantomime as follows:

The examiner having placed the five-year design in front of the subject points with the pencil for a couple of seconds to the rat at the beginning of the Maze. He then moves the pencil slowly in the air above the design until it rests on the rat and the cheese on the right-hand side. He then takes the pencil and draws a line very deliberately from the rat's nose at the starting-point round the first turn. The pencil is then put in the subject's hand and his hand guided along to the end of the line already drawn. The examiner then points to the rat and the cheese and signs to the subject to continue with the test. If he should run up a blocked passage or cross a line the examiner stops the drawing with his hand, indicates the block in the path or the crossed line, shakes his head vigorously, and then supplies the subject with a new sheet and signs for him to begin again.

Three trials may be given in such cases, except where the subject fails entirely to respond. The examiner then draws through the whole design, supplies the subject with a new sheet, and signs for him to do likewise. Only one trial is allowed after the preliminary demonstration.

YEAR VI

Examiner says:

"The rat went in here and found his way to the cheese. You take the pencil and show me where he went without crossing any lines or going up any places that are blocked."

Two trials are allowed, the instructions being repeated verbatim for the second trial. If the child goes up a blocked path he should be allowed to proceed far enough to realize his mistake. The examiner then says, "You cannot get out that way." After a pause of about two seconds the test sheet should be removed and a new one substituted.

YEAR VII

Examiner says:

"Start here and find your way out here." (Examiner indicates entrance and point of exit marked by arrows. This is the last place where the exit is pointed out by the examiner. Should the subject ask at a later test where the opening is he should be told that he must find his way out by himself.)

YEARS VIII, IX, AND X

Examiner says:

"Start here and find your way out." Indicate the starting point "S," but not the exit. In these tests the child may hesitate before beginning and ask "Is this the way out?" The examiner should reply, "There is only one way out, and you must find it yourself." Two trials are allowed. Invert test if accidental success is suspected, or in the case of success following a complete failure in a lower test.

YEAR XI

"Begin here in the middle and find your way right out through these openings without going up any blocked places or crossing any lines."

Point to "S" in the middle of the design, but do not indicate place of exit.

YEARS XII AND XIV

Procedure as before: "Start here and find your way out." Allow four trials on each test.

SCORING

1. The three- and four-year tests are not applied except to very young or very defective children. For each success on the first trial in Tests V to XI add a year of test age to the basic age of four years. For each second trial add a half-year. No credit is allowed for any test failure on the second trial.

2. Four trials are allowed on both the twelve- and fourteen-year tests. If both tests are passed add together the number of trials given in each test and give additional credit as follows:

Sum of Trials in Tests XII and XIV	*Credit to be added to Score already obtained in Tests below XII*
2 trials	4 years
3 trials	3½ years
4 trials	3 years
5 trials	2½ years
6 trials	2 years
7 trials	1½ years
8 trials	1 year

3. If the fourteen-year test is failed credit one year if the twelve-year test is passed on the first, second, or third trial. Credit one half-year if it is passed on the fourth trial.

4. If the twelve-year test is failed and the fourteen-year test passed credit is given as below:

No. of Trials in Test XIV	*Credit to be added to Score already obtained*
1 trial	2 years
2 trials	1½ years
3 trials	1 year
4 trials	½ year

Since the child failed in the test for Year XII previous to his success in Year XIV, the latter test should be inverted and the worse record taken as the basis of the scoring.

By the above scoring method the highest test age obtainable is fifteen years.

The adult test is applied under the following conditions:

1. If the subject is over twelve years of age.*
2. If the combined trials in Tests XII and XIV do not total more than three.
3. If there are no failures or second trials in tests below Test XI.

Credit for success in the adult test is given as follows:

No. of Trials	*Years added to Score already obtained*
1 or 2 trials	2 years
3 trials	1½ years
4 trials	1 year

The maximum score, obtained only when the subject passes all the tests below the adult test on the first trial, and the adult test in one or two trials, is seventeen years. Sample records with the scoring are appended.

EXAMPLES

Example 1

Tests	*No. of Trials*	*Credits*
5-year	2 trials	4½ years
6-year	1 trial	1 year
7-year	2 trials	½ year
8-year	F	0
9-year	1 trial	
9-year (inverted)	2 trials	½ year
10-year	1 trial	1 year
11-year	1 trial	1 year
12-year	3 trials	1½ years
14-year	4 trials	
	TEST AGE	10 years

Note. In the nine-year test the score in the inverted test is taken as it is the worse of the two records.

---

* Older children frequently gain relatively poorer scores than young children because they take the test so seriously and are fearful of failure. This is one reason for allowing only the older children to earn credit in the adult test.

Example 2

Tests	*No. of Trials*	*Credits*
5-year	1 trial	5 years
6-year	1 trial	1 year
7-year	1 trial	1 year
8-year	1 trial	1 year
9-year	2 trials	½ year
10-year	2 trials	½ year
11-year	F	0
12-year	4 trials	½ year
12-year (inverted)	1 trial (no credit)	
14-year	F	0
	TEST AGE	9½ years

Note. In the twelve-year test the original score is taken as it is the worse of the two records.

Example 3

Tests	*No. of Trials*	*Credits*
5-year	1 trial	5 years
6-year	1 trial	1 year
7-year	1 trial	1 year
8-year	2 trials	½ year
9-year	1 trial	1 year
10-year	F	0
11-year	2 trials	0
11-year (inverted)	F	0
	TEST AGE	8½ years

Note. No credit is given for eleven-year success because of failure when test was inverted.

Example 4

Tests	*No. of Trials*	*Credits*
5-year	1 trial	5 years
6-year	1 trial	1 year
7-year	1 trial	1 year
8-year	1 trial	1 year
9-year	1 trial	1 year

Example 4—continued

Tests	*No. of Trials*	*Credits*
10-year	1 trial	1 year
11-year	2 trials	½ year
12-year	1 trial	3½ years
14-year	2 trials	
Adult 1	3 trials	1½ years
	TEST AGE	15½ years

QUALITATIVE SCORING

The qualitative as distinct from the quantitative test-age scoring is concerned with errors in drawing or execution rather than in planning.

The principle upon which it is based is that each person has his characteristic way of approaching and executing a task. The haphazard, careless type of individual who has not achieved any self-standards of performance, and who is disregardful of rules or instructions, will reveal these characteristic faults, especially if he does not know that his work is being closely observed and scored in these particulars. Conversely, the thorough-going, sometimes over-meticulous person can also be detected by his manner of execution in the Maze. The qualitative scoring reduces this observation of incidental errors to a system. The weighting of errors is based on the comparative performance of delinquents.

No criticism of the performance is made by the examiner, nor are any instructions given other than those set forth in the testing procedure. Thus an ordinary application of the quantitative maze will yield a qualitative score, provided all the tests have been applied.

The scoring consists of a system of weighted penalties which are recorded for the following slips in execution. It should be emphasized that to be effective even the slightest infractions must be strictly penalized. Leniency may change the picture materially.

ERROR-POINTS

1. An error occurring in the first third of the design—*i.e.*, before the first arrow marked on each sample design—2 points.

2. Errors occurring in the last third of the design—*i.e.*, after the second arrow marked on each sample design—1 point.

3. Cutting corners—1 point. This error consists in allowing the pencil to touch or cross a line when turning a corner.

4. Crossing lines—2 points. This is scored against the subject every time he touches or crosses a line other than when turning a corner. Touching a line when going through an opening is also scored as a crossed line.

5. Lifting the pencil off the paper at any point except at the exit—3 points. The warning against lifting the pencil is given at the introduction to the five-year test, and not again, until ten pencil-liftings have been counted, when the warning is repeated. "Remember you must keep the pencil on the paper until you have found your way out." For each additional lifting after the second warning a penalty of five points is incurred. *BUT* the maximum error-score to be recorded for pencil-liftings is not to be above 80.

6. Wavy lines—2 points. These are scored for each test—that is, in general irregularity of drawing, equal to or worse than the sample provided. (See illustrative examples, pp. 43–50.)

7. Wrong direction—1 point. This is scored when it is evident that the subject intended to go up the wrong path, but corrected himself before a quantitative error would be normally scored.

8. Each qualitative error in either the five-year test or the six-year design incurs an additional penalty of one point.

The Q-score is the sum of the weighted error-points, and the critical score for males is 29 points, for females 31 points. Scores above these levels are similar to those made by delinquents. The average Q-score for delinquents is about 50 (males), 54 (females).

Note. The qualitative score can be properly derived only from a performance which includes all tests. A high score obtained on the basis of fewer tests than the full scale is, of course, even more significant.

If derived from fewer than nine tests the fact should be recorded with the number applied as a divisor—*e.g.*, $\frac{39}{8}$. This means that the testing stopped at the twelve-year test, but that the Q-score earned up to that point was 39.

ALTERNATIVE PROCEDURE FOR ADULTS

One assumption that time has disproved is that the Maze is an easy test to administer and score. This is far from being the case, as apparently the directions are not explicit enough or are not carefully read and followed by examiners. My former colleague Dr Henry N. Peters, of the Veterans' Administration Hospital, Little Rock, Arkansas, has worked out his own set of directions for use principally with adult subjects. Because of a somewhat different explanatory approach and some special recording which he employs I have thought it expedient to reproduce his set of instructions and examination notes, even though there is some repetition of my own. Two modifications have been made in the Peters form. The first is in the preliminary instructions in which driving a car displaces the rat running through the maze. In another place Dr Peters uses a more lenient penalty for liftings of the pencil (qualitative score). In view of the more explicit explanations the penalty should be three error-points for each lifting up to ten, followed by a five-point penalty after the repeated warning. This form is for use with cases over sixteen years of age only. The regular instructions to which the qualitative norms apply should be used with all younger cases and with primitive adults unfamiliar with cars and streets.

ADMINISTRATION

Place the test sheet before the subject with the print at the bottom towards the subject. Horizontal lines of the maze should be roughly perpendicular to the subject's writing-arm. The examiner should hold the fingers of one hand pressed against the top of the record sheet, in order to keep it flat on the table and to prevent the subject from changing the position.

Instructions. "The lines on these designs are supposed to be solid stone walls and you will see also this drawing of a rat that is supposed to find his way to his food.

"I want you to forget about the rat and imagine these are streets and that you are driving a car in at this entrance [point to the rat on the left side of the five-year maze] and out here.

"But there are special rules. The car cannot turn round or back up, so you must be sure that you do not go up any one-way street, because then your car would have to be hauled out, since it cannot back or reverse. You cannot cross any lines.

"Remember your pencil is the car, so be sure it stays on the road. You can stop the car anywhere and look round, but do not lift the pencil. You can start drawing as soon as you are ready."

(After the tenth lifting say, "You must not lift the pencil off the road. You must think of it as a car, not a plane.")

The above instructions are given with the Maze for Year V. When the subject has completed this one you present him in the same manner with VI, saying:

"Now with this one you start here and go on to here." With Maze VIII and higher the examiner merely points out the starting-point and tells the subject, "Drive in here and find your way out."

It is an error whenever the subject goes into one of the blind alleys. It is counted an error if the subject purposely pushes the pencil more than a sixteenth of an inch across the imaginary line at the entrance to the blind alley. When the patient makes an error, and is aware of it, *the Maze sheet must be taken away from him, and he is presented with a second copy*. Do not anticipate the subject's recognition of his own error by taking the sheet away from him too quickly. If he is moving down a blind alley, and apparently is not aware of the fact, let him go on until he stops. Under no conditions let the subject come out of a blind alley and go on and complete that Maze sheet.

Let the subject choose his own manner of solving the Mazes. Do not interfere with him any more than necessary. Apart from stopping him when he has entered a blind alley, there are only two other acts which should cause the examiner to interfere. At the end of the trial in which a tenth lifting of the pencil occurs the examiner should remind the subject of the lifted-pencil warning. Throughout the testing the examiner should keep a tally count of the number of pencil-lifts, not making any further remarks about them. The other act which the examiner should interfere with is the subject's pre-tracing of the Maze. If the subject tries to pre-trace a Maze either with his finger or pencil-point about an inch or so above the paper the examiner should move his hand over the surface of the Maze and warn the subject that this is not permitted. However, don't let the subject get the idea that you are prohibiting pre-study of the Maze.

The subject is allowed two trials on each Maze from V through XI, four trials on XII, XIV, and the Adult Maze. If the subject makes an error on all of the trials allowed him he is, of course, considered as having failed that Maze.

The quantitative Maze score is arrived at in the following manner. First, determine on which Maze the subject made his first error. Take the age of the Maze below this one as the basic score. Add to this the credits on higher Mazes according to these rules: (1) Up through XI give one-year credit to all Mazes on the first trial; give one-half year credit for all solved on two trials; no credit if the Maze is failed. (2) For XII and XIV give two years for each one solved in one trial; for each trial taken in addition to the first deduct one half-year from the two years' credit. (3) If subject solves the Adult Maze in one or two trials two years' credit is given; if he takes three trials he gets one and a half years' credit; if he takes four trials he is given one year. He is not allowed more than four trials.

These additional credits are added to the basic score, and the total represents the subject's Test Age (corresponding to Mental Age). If one wishes to express this as the T.Q. (corresponding to I.Q.) the tables at pp. 54–61 of this manual should be consulted.

The method of keeping both the quantitative and qualitative scores are shown on the Scoring Sheet at p. 51.

As far as scoring is concerned, testing is stopped either after two successive Maze tests above VIII are failed or when any three Mazes have been failed. However, after the subject has reached the criterion of two successive failures there is no reason why the examiner should not jump up to a higher Maze—say, XII, XIV, or Adult—and see if the subject can do that, especially if for any reason the examiner suspects that the subject might be successful with these higher Mazes. If the subject fails these more difficult Mazes nothing has been lost. On the other hand, if by chance the subject should succeed on one of these difficult Mazes very valuable additional information is obtained. One knows then that the subject's failure on the earlier ones was not due to a lacking in Maze ability, but most probably was due to interference from emotional factors. Regardless of these successes on more difficult Mazes, it should be emphasized that they are not counted in the calculation of the quantitative score. This score should reflect the subject's ability to manage himself in everyday, concrete situations. If this ability is interfered with by emotional factors it should be reflected in his Porteus Maze score.

There are certain rules as to when the Adult Maze should be given and scored. These are as follows: (1) This test should not be given if the subject is under twelve years of age. (2) It should not be given if the total trials on XII and XIV are greater than three. (3) It should not be given if the subject takes more than one trial on any Maze below XI.

INTERPRETATION OF THE QUANTITATIVE MAZE SCORE

With school subjects there is usually found a fairly high correlation between Maze score and Stanford-Binet I.Q. This means that with groups of subjects who are relatively homogeneous with respect to education and training the Mazes and the Binet measure somewhat the same thing. On the other hand, with heterogeneous adults, in non-school situations, the correlation between Mazes and Stanford-Binet is not so very high. This fact is usually interpreted as meaning that the Porteus Mazes measure a special kind of intelligence—an intelligence which may be described as ‘common sense,’ ability to use prudence and foresight in dealing with concrete, visually present situations, or in avoiding the common dangers such as one meets in everyday life (traffic, drugs, reaching for the light switch while standing in the bath, etc.).

It should be remarked that this sort of intelligence is especially pertinent to how an individual gets along in everyday life at the level of the common man-in-the-street. Mazes are thus valuable in predicting how an individual will get along in everyday life. On the other hand, tests like the Stanford-Binet measure the sort of intelligence involved in learning school subjects (memory work, mental concentration, reasoning) and achieving good results. The Stanford-Binet is thus valuable in predicting school performance. It is a well-known fact that a person may do well on the Stanford-Binet (and in school) and yet do miserably on the Porteus Mazes (and in everyday life).

THE QUALITATIVE SCORING OF THE MAZE TEST

The fact of this moderate correlation between the Mazes and the Stanford-Binet (showing that the two are measuring different things), plus the fact that delinquents, prisoners, neurotics, and other socially maladjusted groups are observed to have special difficulty with the Mazes, led the author of the test to make a special investigation of the detailed differences in Maze performances of people who do well and people who do poorly in his tests. The outcome of this study was development of the new scoring method of the Maze—the qualitative scoring. Close examination of the records of poor subjects (especially the obviously maladjusted) disclosed signs of impulsiveness (such as starting into the blind alleys and then stopping the pencil just in time), increased emotional tension (shown by wavy pencil-lines), and loss of self-control (seen in many line-crossings and corner-cuttings in the subject's tracing of the Maze pathways). Hence the author conceived the hypothesis that in these qualities of performance was a possible measure of the emotional stability which was blocking the subject's intellectual ability in Maze-solving.

The test of this hypothesis and the details of the scoring technique were first described in his monograph *Qualitative Performance in the Maze Test*.*

It was found that all socially maladjusted groups measured made reliably higher average qualitative scores than did normal, non-maladjusted groups. The critical score, above which emotional maladjustment is indicated, was found to be about 30. Of course, the more the subject's score exceeds 30, the more likely is the indication to be true and the more intense is the maladjustment.

One arrives at the qualitative score by making a tally of the frequency of occurrence in the subject's Maze tracings of the following:

1. An error—that is, a quantitative error, entering a blind alley—in the first third of the Maze.
2. Any such error in the last third of the Maze.
3. Cutting a corner in making a turn.

---

* Replaced by this volume.

4. Crossing a line.
5. Lifting pencil from the paper.
6. Wavy lines.
7. Turning in the wrong direction, but not going far enough for it to be counted as a quantitative error.
8. Any qualitative error on Year V.
9. Any qualitative error on Year VI.

Abbreviations of these nine types of qualitative errors are entered at the top of columns on the lower half of the accompanying Scoring Sheet. The weights given these items are entered in the row above the abbreviations. To get the qualitative score, one turns through the sheets of a subject's Maze records, beginning with Year V, and enters tallies for each qualitative error observed, in the appropriate column; then one multiplies the total number of each error by the weight at the top of the column and enters the result in the square at the bottom. Lastly, these weighted scores are added and the total entered to the right of "Total points." This is the qualitative score.

APPENDIX 1

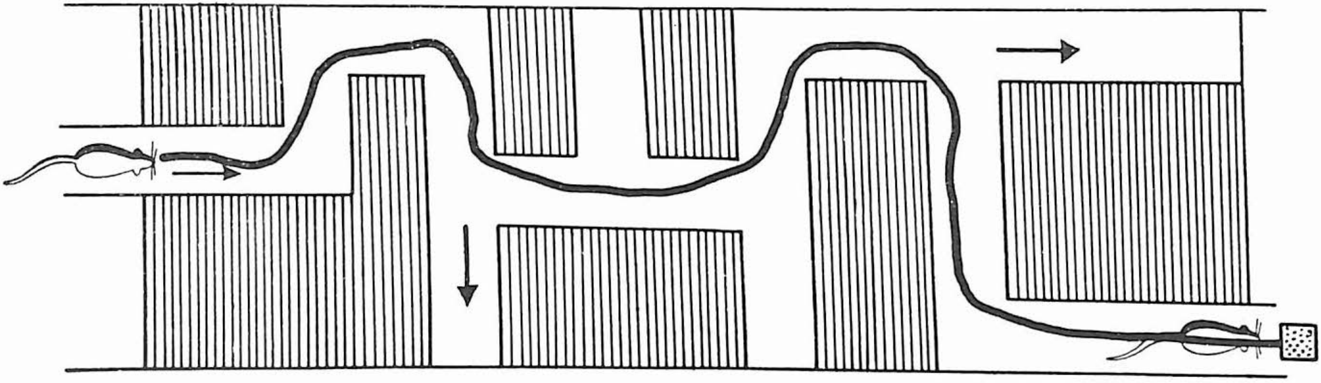
Examples for Scoring Wavy Lines

EXPLANATORY NOTES

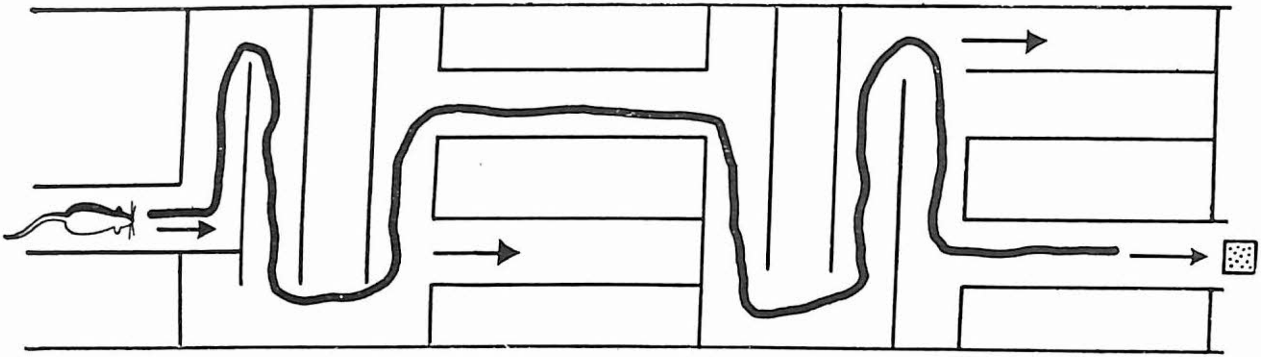
In this Manual the test sheets for years III and IV are not included among the qualitative scoring samples. They are applied only in the examination of very young or feeble-minded children, with whom a Q-score is of little significance. Also, no sample for wavy lines is given for the Adult test. When this is used it can be scored as in the previous tests.

If, as in the case of a delinquent, it is desirable to obtain a full Q-score, testing may be continued even after two consecutive failures. For example, a subject may fail Tests XI and XII, and be allowed four trials in XIV, though these will not be counted in the quantitative or mental-age score.

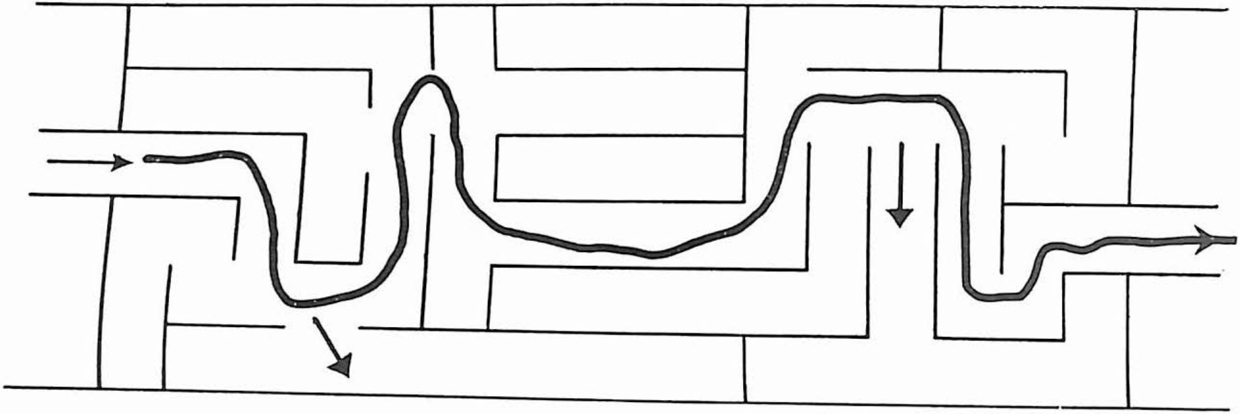
YEAR V



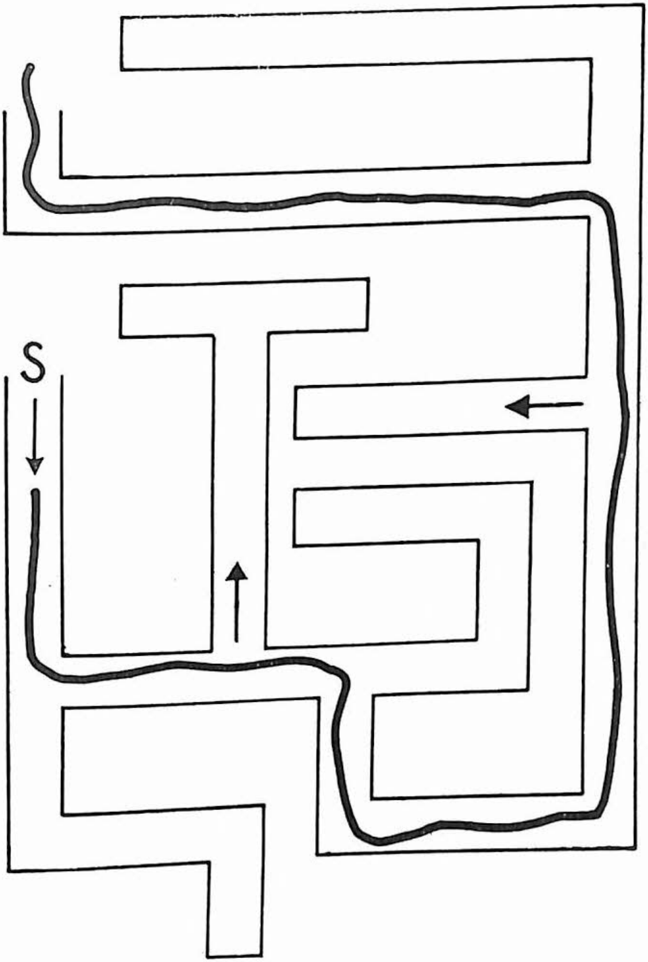
YEAR VI



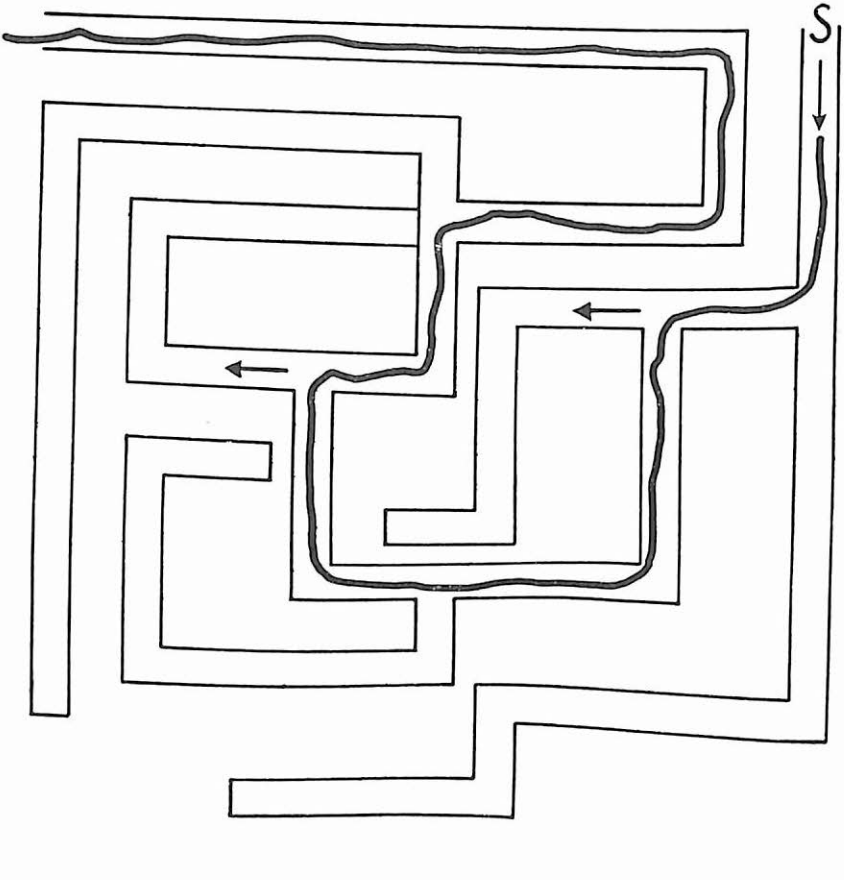
YEAR VII



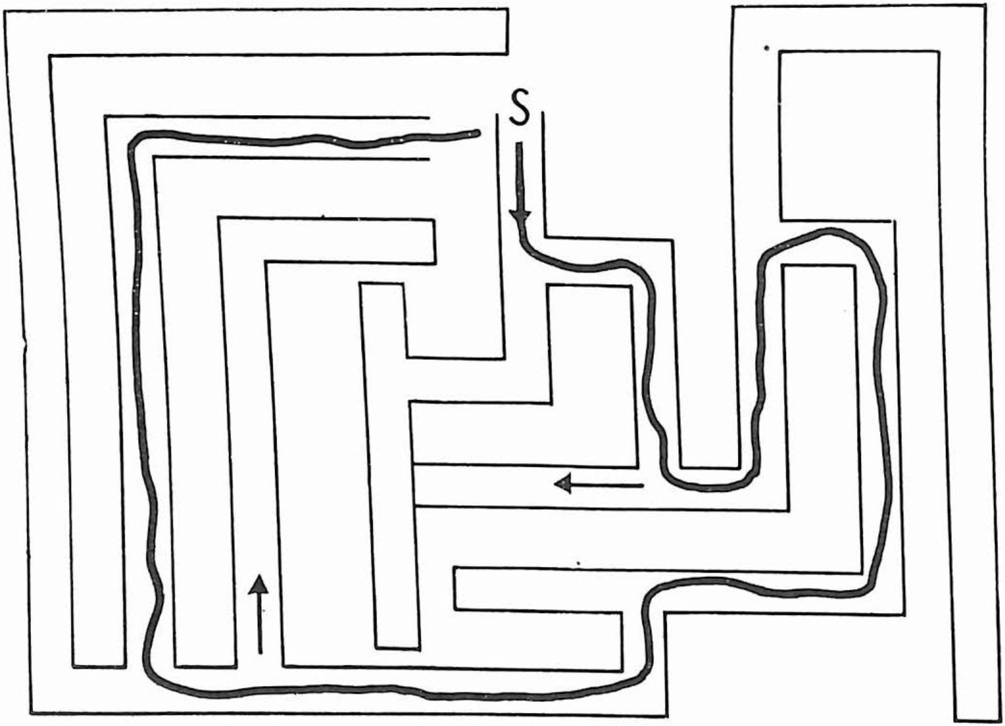
YEAR VIII



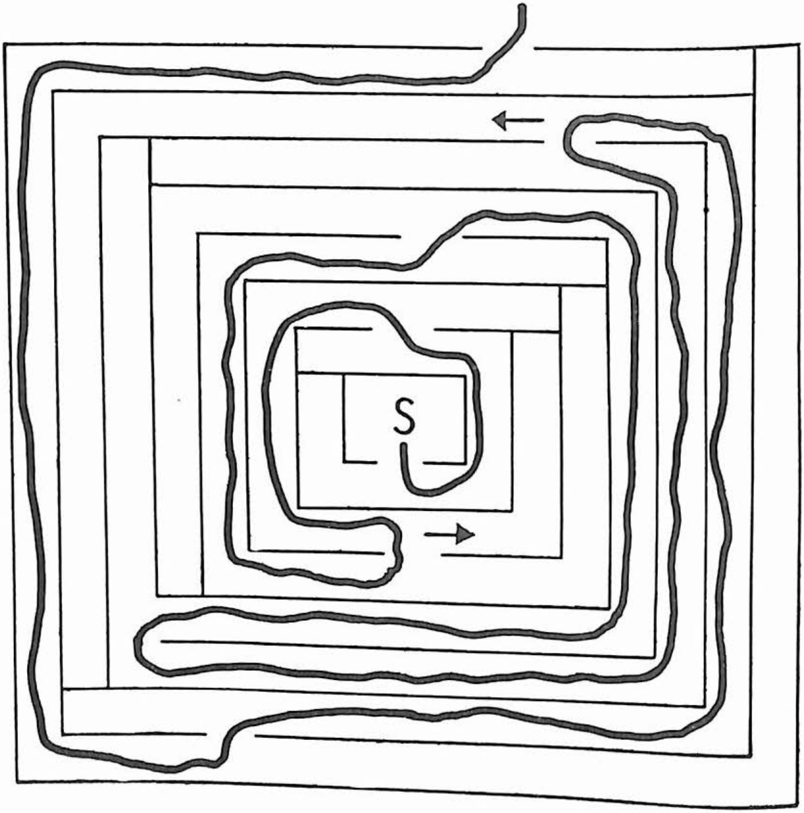
YEAR IX



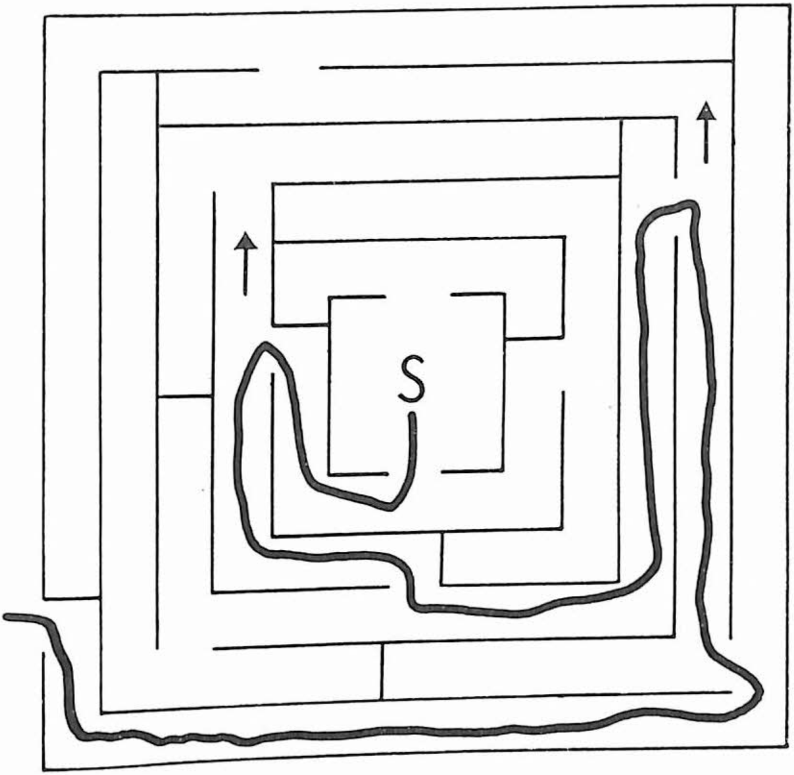
YEAR X



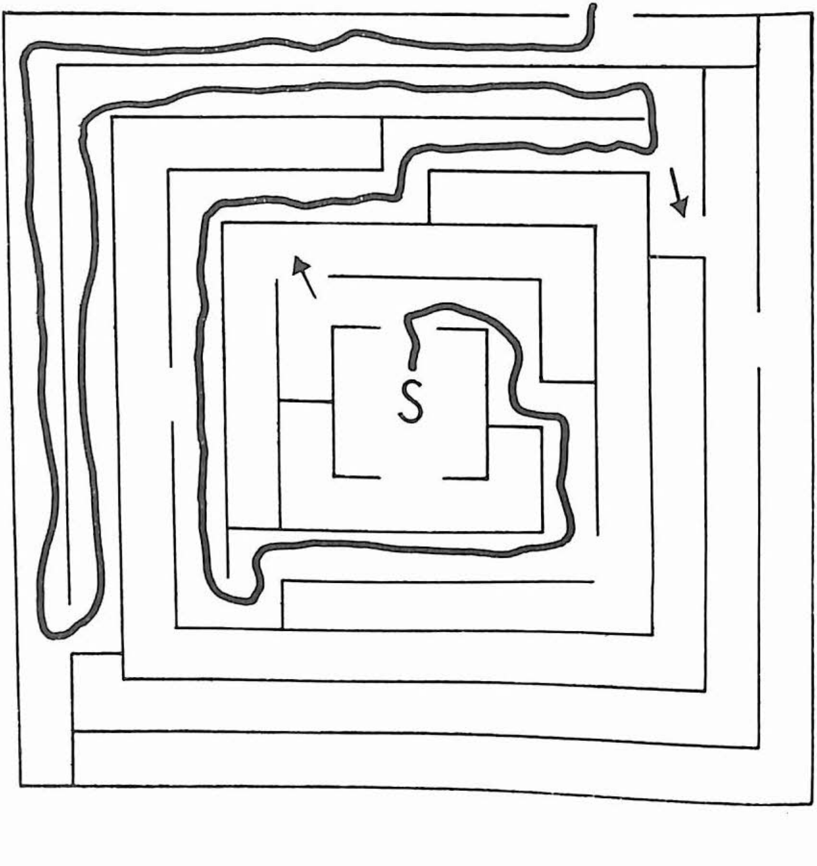
YEAR XI



YEAR XII



YEAR XIV



APPENDIX II

Scoring Sheet

NAME JOHN DOE Date

Born Age 29

MENTAL-AGE SCORE

Basic Score 8 Yrs

Add. Credits 3

Test Age 11

Test Quotient

Test	*Trials*	*Test*	*Trials*
V	1	X	F
VI	1	XI	1 (INV. 1)
VII	1	XII	3 } 7
VIII	1	XIV	4 }
IX	2	Adult	F

QUALITATIVE SCORE

Total Points 98

Weighting	2	1	1	2	3	2	1	1	1
Errors	First 3rd	Last 3rd	Cut Corner	Cross Lines	Lift Pencil	Wavy Lines	Wrong Dir.	Year V	Year VI
No.	||	|||	𝍸 𝍸 ||||	𝍸 𝍸 𝍸 𝍸	𝍸 |	𝍸	𝍸 |	||	|
Weighted Scores	4	3	14	40	18	10	6	2	1

NOTES ON SUBJECT'S REACTIONS

Very hurried, careless execution.

APPENDIX III

The Age-score Ratio

A difficulty which always meets the deviser of tests such as the Maze, which employs the same kind of test material throughout a series, is that young children tend on the average to score above their chronological age, while older children score below. This is due in part to the fact that the increments of ability are uneven year by year, twelve months' development at a lower age being relatively greater than the same chronological increment at a higher age-level. Further, the test quotient obtained by dividing the test by the chronological age is affected by the size of the divisor. As an example, we may take two children, one aged six and advanced a year, the other aged twelve and similarly advanced. Both test a year ahead of their age, but the test quotient (T.Q.) of the first child is 116 and of the other child 108. Hence in any comparison of age groups by test quotients the younger children appear brighter than the older. In order for the test quotient to remain constant the chronological increments of ability must increase, which, however, is not the case.

In reckoning the test quotient for the Maze the writer therefore adopted the plan of adding to the chronological age of the younger children and subtracting from the age of the older children in order to make the divisors more comparable.

The principle involved has already been recognized in the method generally used of taking fourteen years as the upper limit of chronological age when calculating a test quotient. Obviously this gives sixteen-year children a two-year advantage.

It is, of course, foolish to assume that mental development ceases abruptly at fourteen years. There is no doubt that it commences to diminish in rate at about twelve years. In other words, children over fourteen years of age get an advantage in reckoning their test quotients, but thirteen-year children get none.

The writer is using the following plan to obviate this difficulty. For ages twelve years one month to twelve years eleven months the divisor used is twelve years, giving an advantage varying from one to eleven months to children of these ages. From thirteen years on to fifteen years one year is deducted from the actual age before reckoning the test quotient. Thus the advantages of a reduced divisor are spread from twelve to fifteen years, instead of beginning at fourteen years one month, as in the previous system of scoring.

In the lower years children from five years six months to seven years eleven months have six months added to their chronological age. From eight years to eight years six months the writer proposes to use eight years as the divisor. Thus the maximum disadvantage is incurred by the younger children, and it shades off month by month for the older children. This scheme, it has been found, tends to bring the average T.Q. for each age group to about 100. For the convenience of the users of the test a table of test quotients is appended, so that these additions and subtractions need not be made, the test quotients being read directly from the table. The actual age is given in the extreme left-hand column. The procedure is to take the child's actual age as given in the first column and read along the horizontal line until the vertical column corresponding to the mental or test age is reached, where the test quotient (T.Q.) will be found.

TABLE OF

CHRON. AGE	TEST AGE								
	4	4½	5	5½	6	6½	7	7½	8
5.6	67	75	83	92	100	108	117	125	133
7	66	74	82	90	99	107	115	123	132
8	65	73	81	89	97	105	114	122	130
9	64	72	80	88	96	104	112	120	128
10	63	71	79	87	95	103	111	118	126
11	62	70	78	86	94	101	109	117	125
6.0	62	69	77	85	92	100	108	115	123
1	61	68	76	84	91	99	106	114	122
2	60	68	75	83	90	98	105	112	120
3	59	67	74	81	89	96	104	111	119
4	59	66	73	80	88	95	102	110	117
5	58	65	72	80	87	94	101	108	116
6.6	57	64	71	79	86	93	100	107	114
7	56	64	71	78	85	92	99	106	113
8	56	63	70	77	84	91	98	105	112
9	55	62	69	76	83	90	97	103	110
10	55	61	68	75	82	89	95	102	109
11	54	61	67	74	81	88	94	101	108
7.0	53	60	67	73	80	87	93	100	107
1	53	59	66	73	79	86	92	99	105
2	52	59	65	72	78	85	91	98	104
3	52	58	65	71	77	84	90	97	103
4	51	57	64	70	77	83	89	96	102
5	51	57	63	69	76	82	88	95	101

Test Quotients

Test Age										
8½	9	9½	10	10½	11	11½	12	12½	13	13½
142	150	158	167							
140	148	156	164							
138	146	154	162	170						
136	144	152	160	168						
134	142	150	158	166						
132	140	148	156	164	171					
131	138	146	154	162	169					
129	137	144	152	159	167					
128	135	143	150	158	165					
126	133	141	148	156	163	170				
124	132	139	146	154	161	168				
123	130	137	145	152	159	166				
121	129	136	143	150	157	164	171			
120	127	134	141	148	155	162	169			
119	126	133	140	147	153	160	167			
117	124	131	138	145	152	159	166			
116	123	130	136	143	150	157	164	170		
115	121	128	135	142	148	155	162	169		
113	120	127	133	140	147	153	160	167		
112	119	125	132	138	145	152	158	165		
111	117	124	130	137	143	150	157	163	170	
110	116	123	129	135	142	148	155	161	168	
109	115	121	128	134	140	147	153	160	166	
107	114	120	126	133	139	145	152	158	164	171

Chron. Age	Test Age												
	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
7.6	50	56	63	69	75	81	88	94	100	106	113	119	125
7	49	56	62	68	74	80	87	93	99	105	111	118	124
8	49	55	61	67	73	80	86	92	98	104	110	116	122
9	48	55	61	67	73	79	85	91	97	103	109	115	121
10	48	54	60	66	72	78	84	90	96	102	108	114	120
11	48	53	59	65	71	77	83	89	95	101	107	113	119
8.0 to 8.6	47	53	59	65	71	76	82	88	94	100	106	112	118
7	47	52	58	64	70	76	82	87	93	99	105	111	117
8	46	52	58	63	69	75	81	87	92	98	104	110	115
9	46	51	57	63	69	74	80	86	91	97	103	109	114
10	45	51	57	62	68	74	79	85	91	96	102	108	113
11	45	50	56	62	67	73	79	84	90	95	101	107	112
9.0	44	50	56	61	67	72	78	83	89	94	100	106	111
1	44	50	55	61	66	72	77	83	88	94	99	105	110
2	44	49	55	60	65	71	76	82	87	93	98	104	109
3	43	49	54	59	65	70	76	81	86	92	97	103	108
4	43	48	54	59	64	70	75	80	86	91	96	102	107
5	42	48	53	58	64	69	74	80	85	90	96	101	106
9.6		47	53	58	63	68	74	79	84	89	95	100	105
7			52	57	63	68	73	78	83	89	94	99	104
8			52	57	62	67	72	78	83	88	93	98	103
9			51	56	62	67	72	77	82	87	92	97	103
10			51	56	61	66	71	76	81	86	92	97	102
11			50	55	61	66	71	76	81	86	91	96	101

Test Age												
10½	11	11½	12	12½	13	13½	14	14½	15	15½	16	16½
131	138	144	150	156	163	169						
130	136	142	148	155	161	167						
129	135	141	147	153	159	165						
127	133	139	145	152	158	164	170					
126	132	138	144	150	156	162	168					
125	131	137	143	149	154	160	166					
124	129	135	141	147	153	159	165	171				
122	128	134	140	146	151	157	163	169				
121	127	133	138	144	150	156	162	167				
120	126	131	137	143	149	154	160	166				
119	125	130	136	142	147	153	159	164	170			
118	123	129	135	140	146	151	157	163	168			
117	122	128	133	139	144	150	156	161	167			
116	121	127	132	138	143	149	154	160	165	171		
115	120	125	131	136	142	147	153	158	164	169		
114	119	124	130	135	141	146	151	157	162	168		
113	118	123	129	134	139	145	150	155	161	166		
112	117	122	127	133	138	143	149	154	159	165	170	
111	116	121	126	132	137	142	147	153	158	163	168	
110	115	120	125	130	136	141	146	151	157	162	167	
109	114	119	124	129	134	140	145	150	155	160	166	
108	113	118	123	128	133	138	144	149	154	159	164	
107	112	117	122	127	132	137	142	147	153	158	163	
106	111	116	121	126	131	136	141	146	151	156	161	166

CHRON. AGE	TEST AGE 5	5½	6	6½	7	7½	8	8½	9	9½	10	10½
10.0	50	55	60	65	70	75	80	85	90	95	100	105
1	50	55	60	64	69	74	79	84	89	94	99	104
2	49	54	59	64	69	74	79	84	89	93	98	103
3	49	54	59	63	68	73	78	83	88	93	98	102
4	48	53	58	63	68	73	77	82	87	92	97	102
5	48	53	58	62	67	72	77	82	86	91	96	101
10.6	48	52	57	62	67	71	76	81	86	90	95	100
7	47	52	57	61	66	71	76	80	85	90	95	99
8	47	52	56	61	66	70	75	80	84	89	94	98
9	47	51	56	60	65	70	74	79	84	88	93	98
10	46	51	55	60	65	69	74	78	83	88	92	97
11	46	50	55	60	64	69	73	78	82	87	92	96
11.0	45	50	55	59	64	68	73	77	82	86	91	95
1	45	50	54	59	63	68	72	77	81	86	90	95
2	45	49	54	58	63	67	72	76	81	85	90	94
3	44	49	53	58	62	67	71	76	80	84	89	93
4	44	48	53	57	62	66	71	75	79	84	88	93
5	44	48	53	57	61	66	70	74	79	83	88	92
11.6	43	48	52	57	61	65	70	74	78	83	87	91
7	43	47	52	56	60	65	69	73	78	82	86	91
8	43	47	51	56	60	64	69	73	77	81	86	90
9	43	47	51	55	60	64	68	72	77	81	85	89
10	42	46	51	55	59	63	68	72	76	80	85	89
11	42	46	50	55	59	63	67	71	76	80	84	88

Test Age												
11	11½	12	12½	13	13½	14	14½	15	15½	16	16½	17
110	115	120	125	130	135	140	145	150	155	160	165	170
109	114	119	124	129	134	139	144	149	154	159	164	169
108	113	118	123	128	133	138	143	148	152	157	162	167
107	112	117	122	127	132	137	141	146	151	156	161	166
106	111	116	121	126	131	135	140	145	150	155	160	165
106	110	115	120	125	130	134	139	144	149	154	158	163
105	110	114	119	124	129	133	138	143	148	152	157	162
104	109	113	118	123	128	132	137	142	146	151	156	161
103	108	113	117	122	127	131	136	141	145	150	155	159
102	107	112	116	121	126	130	135	140	144	149	153	158
102	106	111	115	120	125	129	134	138	143	148	152	157
101	105	110	115	119	124	128	133	137	142	147	151	156
100	105	109	114	118	123	127	132	136	141	145	150	155
99	104	108	113	117	122	126	131	135	140	144	149	153
99	103	107	112	116	121	125	130	134	139	143	148	152
98	102	107	111	116	120	124	129	133	138	142	147	151
97	101	106	110	115	119	124	128	132	137	141	146	150
96	101	105	109	114	118	123	127	131	136	140	145	149
96	100	104	109	113	117	122	126	130	135	139	143	148
95	99	104	108	112	117	121	125	129	134	138	142	147
94	99	103	107	111	116	120	124	129	133	137	141	146
94	98	102	106	111	115	119	123	128	132	136	140	145
93	97	101	106	110	114	118	123	127	131	135	139	144
92	97	101	105	109	113	117	122	126	130	134	138	143

CHRON. AGE	TEST AGE											
	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½
12.0 to 13.0	42	46	50	54	58	63	67	71	75	79	83	88
1		46	50	54	58	62	66	70	74	79	83	87
2		45	49	53	58	62	66	70	74	78	82	86
3		45	49	53	57	61	65	69	73	78	82	86
4		45	49	53	57	61	65	69	73	77	81	85
5		44	48	52	56	60	64	68	72	77	81	85
13.6		44	48	52	56	60	64	68	72	76	80	84
7		44	48	52	56	60	64	68	72	76	79	83
8		43	47	51	55	59	63	67	71	75	79	83
9		43	47	51	55	59	63	67	71	75	78	82
10		43	47	51	55	58	62	66	70	74	78	82
11		43	46	50	54	58	62	66	70	74	77	81
14.0		42	46	50	54	58	62	65	69	73	77	81
1		42	46	49	53	57	61	65	69	73	76	80
2		42	46	49	53	57	61	65	68	72	76	80
3		42	45	49	53	57	60	64	68	72	75	79
4		41	45	49	53	56	60	64	68	71	75	79
5		41	45	48	52	56	60	63	67	71	75	78
14.6		41	44	48	52	56	59	63	67	70	74	78
7		40	44	48	52	55	59	63	66	70	74	77
8		40	44	48	51	55	59	62	66	70	73	77
9		40	44	47	51	55	58	62	65	69	73	76
10		40	43	47	51	54	58	61	65	69	72	76
11		40	43	47	50	54	57	61	65	68	72	75
15.0		39	43	46	50	54	57	61	64	68	71	75

Test Age												
11	11½	12	12½	13	13½	14	14½	15	15½	16	16½	17
92	96	100	104	108	113	117	121	125	129	133	138	142
91	95	99	103	108	112	116	120	124	128	132	137	141
90	95	99	103	107	111	115	119	123	127	132	136	140
90	94	98	102	106	110	114	118	122	127	131	135	139
89	93	97	101	105	109	114	118	122	126	130	134	138
89	93	97	101	105	109	113	117	121	125	129	133	137
88	92	96	100	104	108	112	116	120	124	128	132	136
87	91	95	99	103	107	111	115	119	123	127	131	135
87	91	95	99	103	107	111	114	118	122	126	130	134
86	90	94	98	102	106	110	114	118	122	125	129	133
86	90	94	97	101	105	109	113	117	121	125	129	132
85	89	93	97	101	105	108	112	116	120	124	128	132
85	88	92	96	100	104	108	112	115	119	123	127	131
84	88	92	96	99	103	107	111	115	118	122	126	130
84	87	91	95	99	103	106	110	114	118	122	125	129
83	87	91	94	98	102	106	109	113	117	121	125	128
83	86	90	94	98	101	105	109	113	116	120	124	128
82	86	89	93	97	101	104	108	112	116	119	123	127
81	85	89	93	96	100	104	107	111	115	119	122	126
81	85	88	92	96	99	103	107	110	114	118	121	125
80	84	88	91	95	99	102	106	110	113	117	121	124
80	84	87	91	95	98	102	105	109	113	116	120	124
80	83	87	90	94	98	101	105	108	112	116	119	123
79	83	86	90	93	97	101	104	108	111	115	119	122
79	82	86	89	93	96	100	104	107	111	114	118	121

List of References

1. Porteus, S. D.: "Motor-intellectual Tests for Mental Defectives" (*Journal of Experimental Pedagogy*, vol. ii, 1915).
2. Porteus, S. D.: "Mental Tests for Feeble-minded: A New Series" (*Journal of Psycho-Asthenics*, vol. xix, June 1915).
3. Porteus, S. D.: "The Measurement of Intelligence: Six Hundred and Fifty-three Children examined by the Binet and Porteus Tests" (*Journal of Educational Psychology*, January 1918).
4. Porteus, S. D.: *Porteus Tests: The Vineland Revision* (Research Publications, Vineland, September 1919).
5. Berry, Richard J. A., and Porteus, S. D.: *Intelligence and Social Valuation* (Research Publications, Vineland, May 1920).
6. Burt, Cyril: *Mental and Scholastic Tests* (London County Council, 1921).
7. Porteus, S. D.: *Guide to Porteus Maze Test* (Research Publications, Vineland, March 1924).
8. Porteus, S. D.: *The Maze Test and Mental Differences* (Smith Printing House, Vineland, 1933).
9. Porteus, S. D.: *Study of Personality of Defectives with a Social Ratings Scale* (Research Publications, Vineland, December 1920).
10. Porteus, S. D.: *Studies in Mental Deviations* (Smith Printing House, Vineland, 1922).
11. Herd, Henry: *The Diagnosis of Mental Deficiency* (Hodder and Stoughton, 1930).
12. Earle, F. M., and Milner, M.: *The Use of Performance Tests of Intelligence in Vocational Guidance* (H.M. Stationery Office, 1929).
13. Ross, Elizabeth: "Vocational Tests for Defectives" (*Studies in Mental Deficiency*, January 1921).
14. Morgenthau, Dorothy R.: "Some Well-known Mental Tests evaluated and compared" (*Archives of Psychology*, No. 52, 1922).
15. Worthington, Myrtle E.: "A Study of Some Commonly Used Performance Tests" (*Journal of Applied Psychology*, June 1926).
16. Gaw, Frances: "A Study of Performance Tests" (*British Journal of Psychology*, April 1923).
17. Vicary, Thomas C.: "An Investigation into the Use of Non-verbal Tests of Intelligence in India" (Unpublished thesis, University of London, 1938).
18. Poull, L., and Montgomery, R.: "The Porteus Maze Test as a Discriminative Measure in Delinquency" (*Journal of Applied Psychology*, April 1929).

19. KARPELES, LOTTA M.: "A Further Investigation of the Porteus Maze as a Discriminative Measure in Delinquency" (*Journal of Applied Psychology*, August 1932).

20. PORTEUS, S. D.: "Mental Tests with Delinquent and Australian Aboriginal Children" (*Psychological Review*, January 1917).

21. PORTEUS, S. D.: *Qualitative Performance in the Maze Test* (Smith Printing House, Vineland, 1942).

22. PORTEUS, S. D.: "Q-scores, Temperament, and Delinquency" (*Journal of Social Psychology*, vol. xxi, 1945).

23. WRIGHT, CATHERINE: "The Qualitative Performance of Delinquent Boys on the Porteus Maze Test" (*Journal of Consulting Psychology*, vol. viii, 1944).

24. GRAJALES, MANUEL L.: "Porteus' Qualitative Maze Test as a Measure of Delinquency" (Unpublished thesis, Fordham University, New York, 1948).

25. WOOD JONES, F., and PORTEUS, S. D.: *The Matrix of the Mind* (University of Hawaii Press, 1929; Edward Arnold, 1929).

26. FREEMAN, W., and WATTS, JAMES: *Psycho-surgery* (Charles F. Thomas, Springfield, Illinois, 1942).

27. FREEMAN, W., and WATTS, JAMES: *Psycho-surgery* (second edition, 1950).

28. PORTEUS, S. D., and KEPNER, R. DE M.: "Mental Changes after Bilateral Prefrontal Lobotomy" (*Genetic Psychological Monographs*, No. 29, 1944).

29. PORTEUS, S. D., and PETERS, HENRY N.: "Maze Test Validation and Psycho-surgery" (*Genetic Psychological Monographs*, No. 36, 1947).

30. METTLER, J. (editor): *Selective Partial Ablation of the Frontal Cortex* (Paul Hoeber, New York, 1949).

31. KING, H. E.: "Psychological Functions" (Chapter XIV of 30, above).

32. SHEER, DANIEL E., and SHUTTLEWORTH, M.: Chapter IX in *Problems of Psycho-surgery* (in preparation).

33. LANDIS, CARNEY, and ERLICK, DWIGHT: "An Analysis of the Porteus Maze as affected by Psycho-surgery" (*American Journal of Psychology*, vol. lxiii, October 1950).

34. SHEER, DANIEL E.: *Psychometric Studies* (Department of Research Psychology, Psychiatric Institute, Columbia University, N.Y.) (in preparation).

35. ROBINSON, MARY F.: "Personality Changes" in *Psycho-surgery* (second edition, 1950).

36. PORTEUS, S. D.: *The Practice of Clinical Psychology* (American Book Co., 1941).

C.R.T., West Be
Library

151·2
POR

50